

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Jun Koyama et al.                      Art Unit : Unknown  
Serial No. : Unassigned                              Examiner : Unknown  
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Title : LIQUID CRYSTAL DISPLAY DEVICE, METHOD OF DRIVING THE SAME,  
AND METHOD OF DRIVING A PORTABLE INFORMATION DEVICE  
HAVING THE LIQUID CRYSTAL DISPLAY DEVICE

Commissioner for Patents  
Washington, D.C. 20231

**PRELIMINARY AMENDMENT**

Prior to examination, please amend the application as follows:

In the claims:

**Amend claims 2-4, 6, 7-10 and 13-29 as follows:**

2. The liquid crystal display device of claim 1, wherein each of said pixels has  $n$  ( $n$  is a natural number equal to or greater than 2) memory circuits and the D/A converter associated with a pixel is configured to convert into analog signals digital signals stored in said  $n$  memory circuits associated with the pixel.

3. The liquid crystal display device of claim 1, wherein each of said pixels has a liquid crystal element that receives as input the analog signals generated by the associated D/A converter.

4. The liquid crystal display device of claim 1, wherein each of said pixels has  $n \times m$  ( $n$  and  $m$  are both natural numbers equal to or greater than 2) memory circuits and the D/A converter associated with a pixel is configured to convert into analog signals  $n$  bit digital signals stored in said  $n \times m$  memory circuits associated with the pixel.

6. A liquid crystal display device according to claim 1, wherein said memory circuits and said D/A converter are arranged so as to overlap a source signal line.

7. A liquid crystal display device according to claim 1, wherein said memory circuits and said D/A converter are arranged so as to overlap a gate signal line.

8. A liquid crystal display device comprising pixels, each of said pixels comprising:  
a liquid crystal element; and

a source signal line, n (n is a natural number equal to or greater than 2) gate signal lines, n TFTs having gate electrodes, n memory circuits, and a D/A converter,

wherein each of said gate electrodes is connected to one of said n gate signal lines, and each of said n TFTs has a source region and a drain region, one of which is connected to said source signal line and the other of which is connected to an input terminal of one of said n memory circuits,

wherein an output terminal of each of said n memory circuits is connected to an input terminal of said D/A converter, and

wherein an output terminal of said D/A converter is connected to said liquid crystal element.

9. A liquid crystal display device comprising pixels, each of said pixels comprising:  
a liquid crystal element; and

n (n is a natural number equal to or greater than 2) source signal lines, a gate signal line, n TFTs having gate electrodes, n memory circuits, and a D/A converter,

wherein each of said gate electrodes is connected to said gate signal line, and each of said n TFTs has a source region and a drain region, one of which is connected to one of said n source signal lines and the other of which is connected to an input terminal of one of said n memory circuits,

wherein an output terminal of each of said n memory circuits is connected to an input terminal of said D/A converter, and

wherein an output terminal of said D/A converter is connected to said liquid crystal element.

10. A liquid crystal display device according to claim 8, wherein:

said liquid crystal display device has a source signal line driving circuit including shift registers, first latch circuits, second latch circuits, and switches,

said first latch circuits hold n bit digital signals upon receiving sampling pulses from said shift registers until said n bit digital signals are transferred to said second latch circuits, and

said switches select said n bit digital signals that have been transferred to said second latch circuits one bit at a time to input said selected signals into said source signal line.

13. A liquid crystal display device according to claim 9, wherein:

said liquid crystal display device has a source signal line driving circuit including shift registers and first latch circuits and n switches,

said first latch circuits hold n bit digital signals upon receiving sampling pulses from said shift registers, and

said n switches input said n bit digital signals stored in said first latch circuits to said n source signal lines.

14. A liquid crystal display device according to claim 1, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

15. A liquid crystal display device according to claim 1, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

16. A liquid crystal display device according to claim 1, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

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17. A method of driving a liquid crystal display device, the method comprising:  
using a liquid crystal display device including a plurality of pixels arranged into a matrix form, each of said plurality of pixels having a plurality of memory circuits and a D/A converter, and  
rewriting data in said plurality of memory circuits of pixels in a specific row or pixels in a specific column out of all said plurality of pixels.

18. A method of driving a liquid crystal display device, the method comprising:  
using a liquid crystal display device having a plurality of pixels and a source signal line driving circuit for inputting video signals into said plurality of pixels, each of said plurality of pixels having a plurality of memory circuits and a D/A converter, and  
stopping an operation of said source signal line driving circuit when a still image is displayed.

19. A method according to claim 17, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

20. A method according to claim 17, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate; and a single crystal wafer.

21. A method according to claim 17, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

22. A method of driving a portable information device comprising a liquid crystal display device and a CPU, the method comprising:

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using a liquid crystal display device that includes pixels, each having a plurality of memory circuits, a D/A converter, and a driving circuit for outputting signals to said plurality of memory circuits;

using a CPU that includes a first circuit for controlling said driving circuit and a second circuit for controlling signals inputted to said portable information device; and

stopping an operation of said first circuit when said liquid crystal display device displays a still image.

23. A method of driving a portable information device comprising a liquid crystal display device and a VRAM, the method comprising:

using a liquid crystal display device that includes pixels, each having a plurality of memory circuits and a D/A converter, and

stopping an operation of reading data from said VRAM when said liquid crystal display device displays a still image.

24. A method of driving a portable information device comprising a liquid crystal display device, the method comprising:

using a liquid crystal display device that includes pixels, each having a plurality of memory circuits and a D/A converter, and

stopping an operation of a source signal line driving circuit of said liquid crystal display device when said liquid crystal display device displays a still image.

25. A method according to claim 22 further comprising reading out data in said plurality of memory circuits once in one frame period.

26. A method of driving a portable information device comprising a liquid crystal display device, the method comprising:

using a liquid crystal display device having a plurality of pixels arranged in a matrix form, each of said plurality of pixels having a plurality of memory circuits and a D/A converter; and

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rewriting data in said plurality of memory circuits of pixels in a specific row or pixels in a specific column out of all said plurality of pixels.

27. A method according to claim 22, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

28. A method according to claim 22, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

29. A method according to claim 22, wherein said portable information device is one selected from the group consisting of a cellular phone, a personal computer, a navigation system, a personal digital assistants, and an electronic book.

**Add claims 30-69 as follows:**

--30. A liquid crystal display device according to claim 2, wherein said memory circuits and said D/A converter are arranged so as to overlap a source signal line.

31. A liquid crystal display device according to claim 3, wherein said memory circuits and said D/A converter are arranged so as to overlap a source signal line.

32. A liquid crystal display device according to claim 4, wherein said memory circuits and said D/A converter are arranged so as to overlap a source signal line.

33. A liquid crystal display device according to claim 5, wherein said memory circuits and said D/A converter are arranged so as to overlap a source signal line.

34. A liquid crystal display device according to claim 2, wherein said memory circuits and said D/A converter are arranged so as to overlap a gate signal line.

35. A liquid crystal display device according to claim 3, wherein said memory circuits and said D/A converter are arranged so as to overlap a gate signal line.

36. A liquid crystal display device according to claim 4, wherein said memory circuits and said D/A converter are arranged so as to overlap a gate signal line.

37. A liquid crystal display device according to claim 5, wherein said memory circuits and said D/A converter are arranged so as to overlap a gate signal line.

38. A liquid crystal display device according to claim 2, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

39. A liquid crystal display device according to claim 3, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

40. A liquid crystal display device according to claim 4, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

41. A liquid crystal display device according to claim 5, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

42. A liquid crystal display device according to claim 8, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

43. A liquid crystal display device according to claim 9, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

44. A liquid crystal display device according to claim 2, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

45. A liquid crystal display device according to claim 3, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

46. A liquid crystal display device according to claim 4, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

47. A liquid crystal display device according to claim 5, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

48. A liquid crystal display device according to claim 8, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

49. A liquid crystal display device according to claim 9, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

50. A liquid crystal display device according to claim 2, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a



video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

51. A liquid crystal display device according to claim 3, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

52. A liquid crystal display device according to claim 4, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

53. A liquid crystal display device according to claim 5, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

54. A liquid crystal display device according to claim 8, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

55. A liquid crystal display device according to claim 9, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

56. A method according to claim 18, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

57. A method according to claim 18, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate; and a single crystal wafer.

58. A method according to claim 18, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

59. A method according to claim 23, further comprising reading out data in said plurality of memory circuits once in one frame period.

60. A method according to claim 24, further comprising reading out data in said plurality of memory circuits once in one frame period.

61. A method according to claim 23, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

62. A method according to claim 24, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

63. A method according to claim 26, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

64. A method according to claim 23, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

65. A method according to claim 24, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

66. A method according to claim 26, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

67. A method according to claim 23, wherein said portable information device is one selected from the group consisting of a cellular phone, a personal computer, a navigation system, a personal digital assistants, and an electronic book.

68. A method according to claim 24, wherein said portable information device is one selected from the group consisting of a cellular phone, a personal computer, a navigation system, a personal digital assistants, and an electronic book.

69. A method according to claim 26, wherein said portable information device is one selected from the group consisting of a cellular phone, a personal computer, a navigation system, a personal digital assistants, and an electronic book.--

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**Version with markings to show changes made**

In the claims:

**Claims 2-4, 6, 7-10 and 13-29 have been amended as follows:**

2. (Amended) [A] The liquid crystal display device **[comprising pixels]** of claim 1, wherein each of said pixels has n (n is a natural number equal to or greater than 2) memory circuits and **[a]** the D/A converter **[for converting]** associated with a pixel is configured to convert into analog signals digital signals stored in said n memory circuits **[into analog signals]** associated with the pixel.

3. (Amended) [A] The liquid crystal display device **[comprising pixels,]** of claim 1, wherein each of said pixels **[having]** has a liquid crystal element **[to which analog signals are inputted,**  
wherein each of said pixels has n (n is a natural number equal to or greater than 2) memory circuits and a D/A converter for converting digital signals stored in said n memory circuits into said analog signals] that receives as input the analog signals generated by the associated D/A converter.

4. (Amended) [A] The liquid crystal display device **[comprising pixels]** of claim 1, wherein each of said pixels has n x m (n and m are both natural numbers equal to or greater than 2) memory circuits and **[a]** the D/A converter **[for converting]** associated with a pixel is configured to convert into analog signals n bit digital signals stored in said n x m memory circuits **[into analog signals]** associated with the pixel.

6. (Amended) A liquid crystal display device according to **[any one of claims 1-5]** claim 1, wherein said memory circuits and said D/A converter are arranged so as to overlap a source signal line.

7. (Amended) A liquid crystal display device according to **[any one of claims 1-5]** claim 1, wherein said memory circuits and said D/A converter are arranged so as to overlap a gate signal line.

8. (Amended) A liquid crystal display device comprising pixels, each of said pixels comprising:

a liquid crystal element; and

a source signal line,  $n$  ( $n$  is a natural number equal to or greater than 2) gate signal lines,  $n$  TFTs having gate electrodes,  $n$  memory circuits, and a D/A converter,

wherein each of said gate electrodes is connected to one of said  $n$  gate signal lines, and each of said  $n$  TFTs has a source region and a drain region, one of which is connected to said source signal line and the other of which is connected to an input terminal of one of said  $n$  memory circuits,

wherein an output terminal of each of said  $n$  memory circuits is connected to an input terminal of said D/A converter, and

wherein an output terminal of said D/A converter is connected to said liquid crystal element.

9. (Amended) A liquid crystal display device comprising pixels, each of said pixels comprising:

a liquid crystal element; and

$n$  ( $n$  is a natural number equal to or greater than 2) source signal lines, a gate signal line,  $n$  TFTs having gate electrodes,  $n$  memory circuits, and a D/A converter,

wherein each of said gate electrodes is connected to said gate signal line, and each of said  $n$  TFTs has a source region and a drain region, one of which is connected to one of said  $n$  source signal lines and the other of which is connected to an input terminal of one of said  $n$  memory circuits,

wherein an output terminal of each of said  $n$  memory circuits is connected to an input terminal of said D/A converter, and

wherein an output terminal of said D/A converter is connected to said liquid crystal element.

10. (Amended) A liquid crystal display device according to claim 8, wherein:

**[wherein]** said liquid crystal display device has a source signal line driving circuit including shift registers, first latch circuits, second latch circuits, and switches, **[and]**

**[wherein]** said first latch circuits hold n bit digital signals upon receiving sampling pulses from said shift registers until said n bit digital signals are transferred to said second latch circuits, and

said switches select said n bit digital signals that have been transferred to said second latch circuits one bit at a time to input said selected signals into said source signal line.

13. (Amended) A liquid crystal display device according to claim 9, wherein:

**[wherein]** said liquid crystal display device has a source signal line driving circuit including shift registers and first latch circuits and n switches, **[and]**

**[wherein]** said first latch circuits hold n bit digital signals upon receiving sampling pulses from said shift registers, and

said n switches input said n bit digital signals stored in said first latch circuits to said n source signal lines.

14. (Amended) A liquid crystal display device according to **[any one of claims 1-5, 8, and 9]** claim 1, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

15. (Amended) A liquid crystal display device according to **[any one of claims 1-5, 8, and 9]** claim 1, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

16. (Amended) A liquid crystal display device according to **[any one of claims 1-5, 8, and 9]** claim 1, wherein said liquid crystal display device is incorporated in one selected from the group consisting of a mobile telephone, a video camera, a mobile computer, a head mount display, a television set, a portable electronic book, a personal computer, and a digital camera.

17. (Amended) A method of driving a liquid crystal display device, the method comprising:

using a liquid crystal display device including a plurality of pixels arranged into a matrix form, [wherein] each of said [plural] plurality of pixels [has] having a plurality of memory circuits and a D/A converter, and

**[wherein]** rewriting data [are rewritten] in said plurality of memory circuits of pixels in a specific row or pixels in a specific column out of all said plurality of pixels.

18. (Amended) A method of driving a liquid crystal display device, the method comprising: **[a]**

using a liquid crystal display device having a plurality of pixels and a source signal line driving circuit for inputting video signals into said plurality of pixels, [wherein] each of said plurality of pixels [has] having a plurality of memory circuits and a D/A converter, and

**[wherein]** stopping an operation of said source signal line driving circuit [is stopped] when a still image is displayed.

19. (Amended) A method according to claim 17 **[or 18]**, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

20. (Amended) A method according to claim 17 **[or 18]**, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate; and a single crystal wafer.

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stopping an operation of a source signal line driving circuit of said liquid crystal display device **[is stopped]** when said liquid crystal display device displays a still image.

25. (Amended) A method according to **[any one of claims 22-24, wherein]** claim 22 further comprising reading out data in said plurality of memory circuits **[are read out]** once in one frame period.

26. (Amended) A method of driving a portable information device comprising a liquid crystal display device, **[wherein]** the method comprising:

**[said]** using a liquid crystal display device **[has]** having a plurality of pixels arranged **[into]** in a matrix form[;], each of said plurality of pixels **[has]** having a plurality of memory circuits and a D/A converter; and

**[said liquid crystal display device rewrites]** rewriting data in said plurality of memory circuits of pixels in a specific row or pixels in a specific column out of all said plurality of pixels.

27. (Amended) A method according to **[any one of claims 22-24, and 26]** claim 22, wherein said memory circuits are selected from the group consisting of static random access memories (SRAM), ferroelectric random access memories (FeRAM), and dynamic random access memories (DRAM).

28. (Amended) A method according to **[any one of claims 22-24, and 26]** claim 22, wherein said memory circuits are formed over one selected from the group consisting of a glass substrate, a plastic substrate, a stainless steel substrate, and a single crystal wafer.

29. (Amended) A method according to **[any one of claims 22-24, and 26]** claim 22, wherein said portable information device is one selected from the group consisting of a cellular phone, a personal computer, a navigation system, a personal digital assistants, and an electronic book.